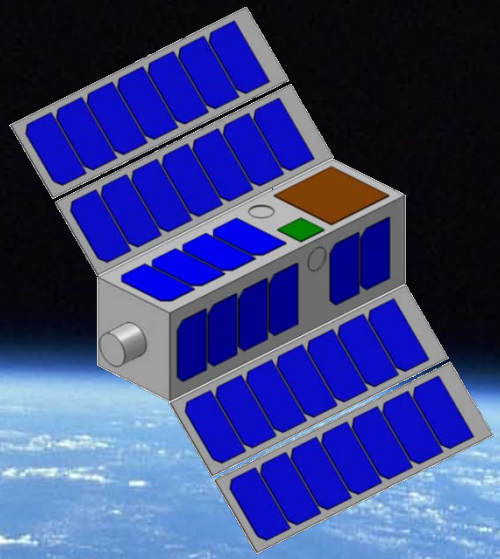
tyvak™
NANO-SATELLITE SYSTEMS LLC

Proximity Operations Nano-Satellite Flight Demonstration (PONSFD) Overview



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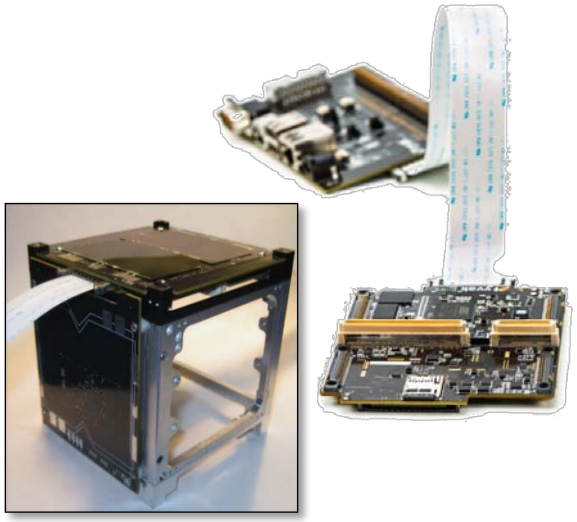
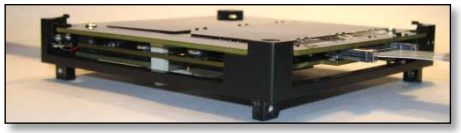
Tyvak Company Background and Overview

Tyvak Nano-Satellite Systems LLC ™

- **Tyvak was Formed to Address Unfulfilled and Growing CubeSat Needs**
  - Needed spacecraft performance and complete system solutions were not supported by existing component and kit-focused suppliers
  - Need for advanced “next generation” CubeSat components and complete vehicles to support operational and scientifically relevant missions
  - Provide complete program life-cycle expertise and mission development
- **Founded by Scott MacGillivray, Dr. Jordi Puig-Suari, and Other CubeSat Experienced Engineers**
- **Provide Range of NanoSat Products and Services**
  - Complete CubeSat bus and vehicles for advanced missions
  - Direct sales of select components and product suites to support other organization’s in-house projects
  - Research and development of advanced “next generation” CubeSat products
  - Launch integration services





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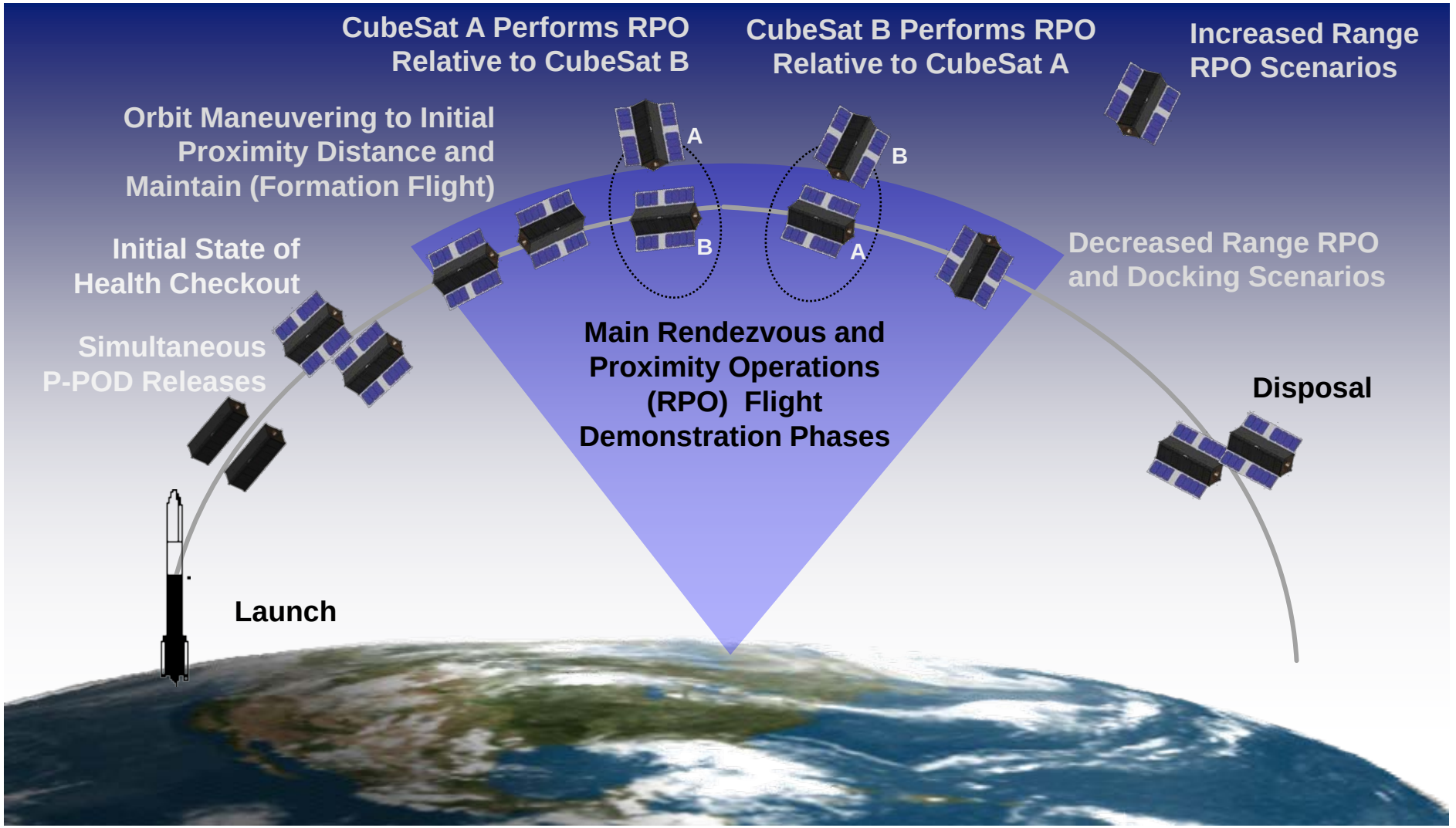
PONSFD Mission Goals

- **Design, Develop, and Demonstrate Rendezvous and Proximity Operations to a Support Inspection Mission Utilizing a CubeSat**
  - **Utilize a Nano-Satellite Class (< 10 kg) Space Vehicle**
  - **Validate use of completely new set of low power miniature components and software approach**
    - **Demonstrate technology and operations applicable to future operational nano-satellite capabilities and operations**
  - **Demonstrate Proximity Operations from various distances, approach scenarios, and lighting conditions**
    - **Nominal operating distances: 50m to 2km**
    - **Full Range of Distances: 0.5m to 25km**
  - **Demonstrate docking between two vehicles**
    - **Safely approach and make contact between test vehicles**
- **Program Represents a 10x Reduction in Space Vehicle Size and Program Cost for a Proximity Operations Flight Experiment**

PONSFD Funded by the Small Spacecraft Technology Program within the NASA Space Technology Mission Directorate

Baseline Operations Concept



Key CubeSat Vehicle Features and Capabilities

- Leverages Tyvak's High Performance Endeavour Components

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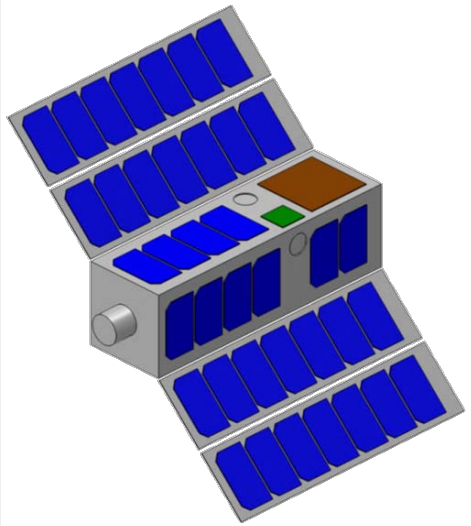
- **C&DH (Leverages Tyvak's Intrepid System)**
  - Atmel Based Main S/C Processor
  - Linux Software Libraries
- **EPS**
  - Power Management and Distribution (PMAD) Electronics Based on Flight Proven Designs
  - Deployable & Body Solar Panels
  - High Capacity Li-ion Battery Module
- **ADCNS**
  - Multiple 1GHz ARM Processors
  - Next Generation Star Trackers
  - Next Generation Miniature Reaction Wheels
  - Multi-Thruster Propulsion Module
  - GPS Receiver and Antennas
- **TT&C**
  - UHF for main communications
  - S-Band Downlink for mission data
  - Inter-Satellite Link
- **RPOD Module**
  - Imager Based System
  - Maneuver and Trajectory Planning
  - Universal Docking Mechanism



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Key Mission and Technology Elements Demonstrated

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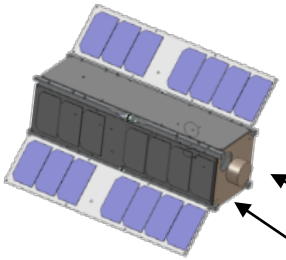


NanoSat Proximity Operations
- Sensors and software for range & range rate determination
- Cooperative sensors

NanoSat Docking
- Close-in co-op aids and sensors
- Universal Docking mechanism

Ranging

Miniature, Low Power Inter-Satellite Link

NanoSat S-Band Comm
- TT&C and Mission Data (e.g., RPO sensor and images)

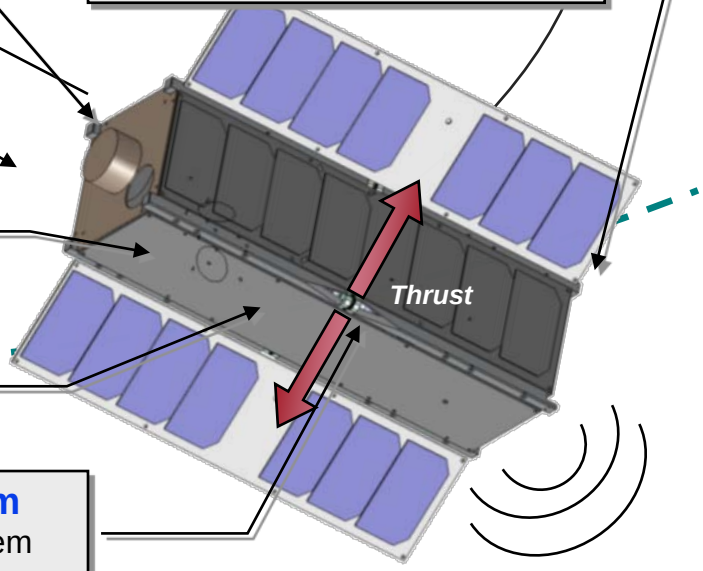
Data

GN&C Algorithms
- GN&C algorithms running on high performance, low power processors

Advanced Capability CubeSat
- Fully functional Space Vehicle
- On-Board Processing and Storage

ADCNS Sensors and Actuators
- Precision Star Trackers and Reaction Wheels
- Miniature, Low Power GPS Receiver & Antennas

Precision Control Propulsion System
- Highly integrated miniature propulsion system for proximity maneuvering



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Thank You